Stoller
Grand Junction Office established 1959

299-W10-XX (C4105)
Log Data Report

Borehole Information:

Borehole: 299-W10-XX (C4105)			**Site:** SW of Tank T-106		
Coordinates (WA State Plane)		**GWL (ft)[1]:** Not Reached		**GWL Date:** 2/13/2003	
North	**East**	**Drill Date**	**TOC[2] Elevation**	**Total Depth (ft)**	**Type**
n/a[3]	n/a	Feb. 2003	n/a	128.9	Percussion

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	3.45	7	6	1/2	+3.45	128.62
The driller was the source for the casing information.						

Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drill pipe.

Logging Equipment Information:

Logging System:	Gamma 3E (RLS-1)		**Type:** 70% HPGe
Calibration Date:	10/2002	**Calibration Reference:**	GJO-2002-386-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 3F		**Type:** Moisture (H380932510)
Calibration Date:	02/03	**Calibration Reference:**	GJO-2003-417-TAC
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2 & Repeat	3	4	5
Date	2/13/03	2/18/03	2/19/03		
Logging Engineer	Kos	Kos	Kos		
Start Depth (ft)	0.0	35.5	105.0		
Finish Depth (ft)	36.5	118.0	129.0		
Count Time (sec)	150	150	150		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	0.5	0.5	0.5		
ft/min	N/A[3]	N/A	N/A		
Pre-Verification	CE071CAB	CE081CAB	CE091CAB		
Start File	CE071000	CE081000	CE091000		
Finish File	CE071073	CE081165	CE091048		

Log Run	1	2 & Repeat	3	4	5
Post-Verification	CE071CAA	CE081CAA	CE091CAA		
Depth Return Error (in.)	0	1 low	0		
Comments	See logging notes below.	See logging notes below.	See logging notes below.		

Neutron-Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2	3	4
Date	2/19/03	2/19/03		
Logging Engineer	Kos	Kos		
Start Depth (ft)	0.0	100.0		
Finish Depth (ft)	128.5	114.75		
Count Time (sec)	N/A	N/A		
Live/Real	N/A	N/A		
Shield (Y/N)	N	N		
MSA Interval (ft)	0.25	0.25		
ft/min	0.9	0.9		
Pre-Verification	CF012CAB	CF012CAB		
Start File	CF012000	CF012515		
Finish File	CF012514	CF012574		
Post-Verification	CF012CAA	CF012CAA		
Depth Return Error (ft)	N/A	+0.25		
Comments		Repeat survey		

Logging Operation Notes:

Zero reference was the ground surface, and the borehole was logged through drill pipe. Logging was performed with a centralizer installed on the sonde. Data were collected using Gamma 3E (RLS-1), HO 68B-4330. Pre- and post-survey verification measurements for Gamma 3E employed the Amersham KUT (^{40}K, ^{238}U, and ^{232}Th) verifier with serial number 118. The verification spectra were collected with the verifier positioned on the steel drill deck approximately 3 ft above the ground. This positioning may have caused the low ^{40}K counts per second (cps). The interval between 105 and 118 ft is the repeat survey.

During SGLS logging, one fine-gain adjustment was needed to maintain the 1460 keV (^{40}K) photopeak at a pre-described channel. The fine gain was adjusted after file CE081147.

Analysis Notes:

Analyst:	Sobczyk	Date:	2/21/03	Reference:	GJO-HGLP 1.6.3, Rev. 0

SGLS pre-run and post-run verification spectra were collected at the beginning and end of each day and compared to the control limits established on 12/05/2002. The post-run verification spectra were all within the control limits. The pre-run verification spectra were all slightly below the control limits for the peak counts per second at the 1461-keV photopeak. Spectra CE071CAB and CE081CAB were also slightly above the control limit for the 609-keV full-width at half-maximum value. The peak counts per second at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were stable and between 1 and 4 percent of one another. Examinations of spectra indicate that the detector functioned normally during all of the logging runs, and the spectra are accepted.

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The verification spectra were all within the control limits.

SGLS log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source file: G3EOct02.xls), using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. Data were analyzed using a uniform casing correction based on a casing thickness of 0.562 in. to a depth of 128.6 ft. This casing thickness was mandated by CHG personnel and is slightly thicker than the actual field measurement. Only one SGLS station was recorded below 128.6 ft, where open-hole conditions were assumed. A water correction was not needed or applied to the SGLS data. For the 70% HPGe detector, dead time at background count rates varies from 2 to 6 percent, averaging about 4 percent. This appears to be due to random fluctuation, as it does not correlate with count rate. Apparently, this fluctuation is an operational characteristic of the detector. Experiments with the detector in the calibration models indicate that the dead time is a function of count rate and that a dead time correction function similar to that developed for the SGLS can be used. Dead time values less than 10 percent should be ignored. Dead time corrections are required when dead time exceeds 18 percent. As the dead time did not exceed 18 percent, a dead time correction was not needed or applied.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. Data were analyzed using a uniform casing correction based on a casing thickness of 0.28 in. to a depth of 128.6 ft. Calibration data are available only for 6-in. casing with a thickness of 0.28 in. No casing correction function is available for this neutron log. The effect of the thicker casing may be to underestimate the moisture content. ***On June 17, 2003, neutron moisture logs were revised to reflect a casing thickness of 0.562 in. and 6-in. ID borehole. A casing correction factor of 1.353 was applied to the data.***

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, naturally occurring radionuclides (^{40}K, ^{238}U, and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it exhibited slightly higher net counts per second. In addition, a combination plot in a format requested by CHG is also included.

Results and Interpretations:

^{137}Cs, ^{60}Co, and ^{154}Eu were the man-made radionuclides detected in this borehole. ^{137}Cs was detected at the ground surface (0 and 0.5 ft). The maximum apparent activity was 0.4 pCi/g at a log depth of 0.5 ft. ^{137}Cs was also detected at 6.5, 81.5, 113.5, and 116.5 ft with concentrations near its MDL of approximately 0.2 pCi/g. After examination of the spectra at these depths, it was determined that there is no evidence of a photopeak at 662 keV. These reported peaks are probably the result of statistical fluctuation. ^{60}Co was detected continuously from 48.5 ft through 122 ft. The range of concentrations was from the 0.1 pCi/g to 15 pCi/g, which was measured at 107 ft. ^{60}Co was also detected at 126.5 ft near its MDL of approximately 0.1 pCi/g. ^{154}Eu was detected in the interval from 48.5 through 51 ft at concentrations ranging from 1 pCi/g to 21 pCi/g, which was measured at 49.5 ft. ^{154}Eu was detected in the interval from 57.5 through 66.5 ft. Concentrations ranged from 0.5 to 4.3 pCi/g. The MDL for ^{154}Eu was approximately 0.3 pCi/g. ^{152}Eu was not detected.

The behavior of the ^{238}U log suggests that radon may be present inside the borehole casing. Determination of ^{238}U is based on measurement of gamma activity at 609 and/or 1764 keV associated with ^{214}Bi, under the assumption of secular equilibrium in the decay chain. However, ^{214}Bi is also a short-term daughter of ^{222}Rn. When radon is present, ^{214}Bi will tend to "plate" onto the casing wall and will quickly reach equilibrium with ^{222}Rn. Because the additional ^{214}Bi resulting from radon is on the inside of the casing, the effect of the casing correction is to amplify the 609 photopeak relative to the 1764 photopeak. (The magnitude of the casing correction factor decreases with increasing energy, but gamma rays originating inside the casing are not attenuated.) This effect is observed in log run 1 (0 to 36.5 ft). The effects of radon appear to be minimal in log run 3 (105 to 129 ft). The reason for variations in radon content between log runs on successive days is not known. Variations in radon content in boreholes are probably related to variations in surface weather conditions. Radon daughters such as ^{214}Bi may also "plate" onto the sonde itself. When this occurs, there is a gradual increase in total counts as well as photopeak counts associated with ^{214}Bi and ^{214}Pb. This phenomenon appears to best explain the observed discrepancy in ^{238}U values and total gamma between runs 1 and 2.

Recognizable changes in the KUT and total gamma logs occurred in this borehole. At 37 ft, there is a 4-pCi/g increase in ^{40}K concentration. This increase in apparent ^{40}K concentration corresponds with the Hanford H2. The 4-pCi/g decrease in ^{40}K concentration at 50 ft in the Hanford H2 is a distinct transition that has been mapped in the T Tank Farm. In this borehole, the highest concentration of ^{154}Eu was measured at 49.5 ft. This transition from the overlying fine-grained portion of the H2 to the coarser portion of the H2 appears to influence the migration of gamma-ray-emitting radionuclides (Sobczyk 2001). Between 82 and 92 ft, the fine-grained member of the Cold Creek Unit (formerly known as the Early Palouse Soil) is shown by an 0.5-pCi/g increase in ^{232}Th. A 10-pCi/g decrease in ^{40}K and a 0.5-pCi/g decrease in ^{232}Th concentration occur at 92 ft. ^{238}U increases by more than 1.0 pCi/g in the interval between 101 and 104 ft. On the basis of low ^{40}K and ^{232}Th concentrations, the carbonate-rich paleosols of the Cold Creek Unit are interpreted as being between 92 and 106 ft. The top of the Ringold is picked at 107 ft. ^{60}Co has broken through to the Ringold despite the presence of the fine-grained Cold Creek Unit.

The plots of the repeat logs demonstrate good repeatability of the SGLS data for the man-made and natural radionuclides at energy levels of 662, 1173, 1333, 609, 1461, 1764, and 2614 keV. The ^{137}Cs concentration based on the 662-keV photopeak does not repeat at 113.5 and 116.5 ft. The cause of this variation is probably the result of statistical fluctuation.

References:

Sobczyk, S.M., 2001. *Subsurface Interpretation of the T Tank Farm, Hanford Site, Washington, Based on Gamma Ray Logging*, Department of Environmental Restoration and Waste Management, Nez Perce Tribe, Lapwai, Idaho.

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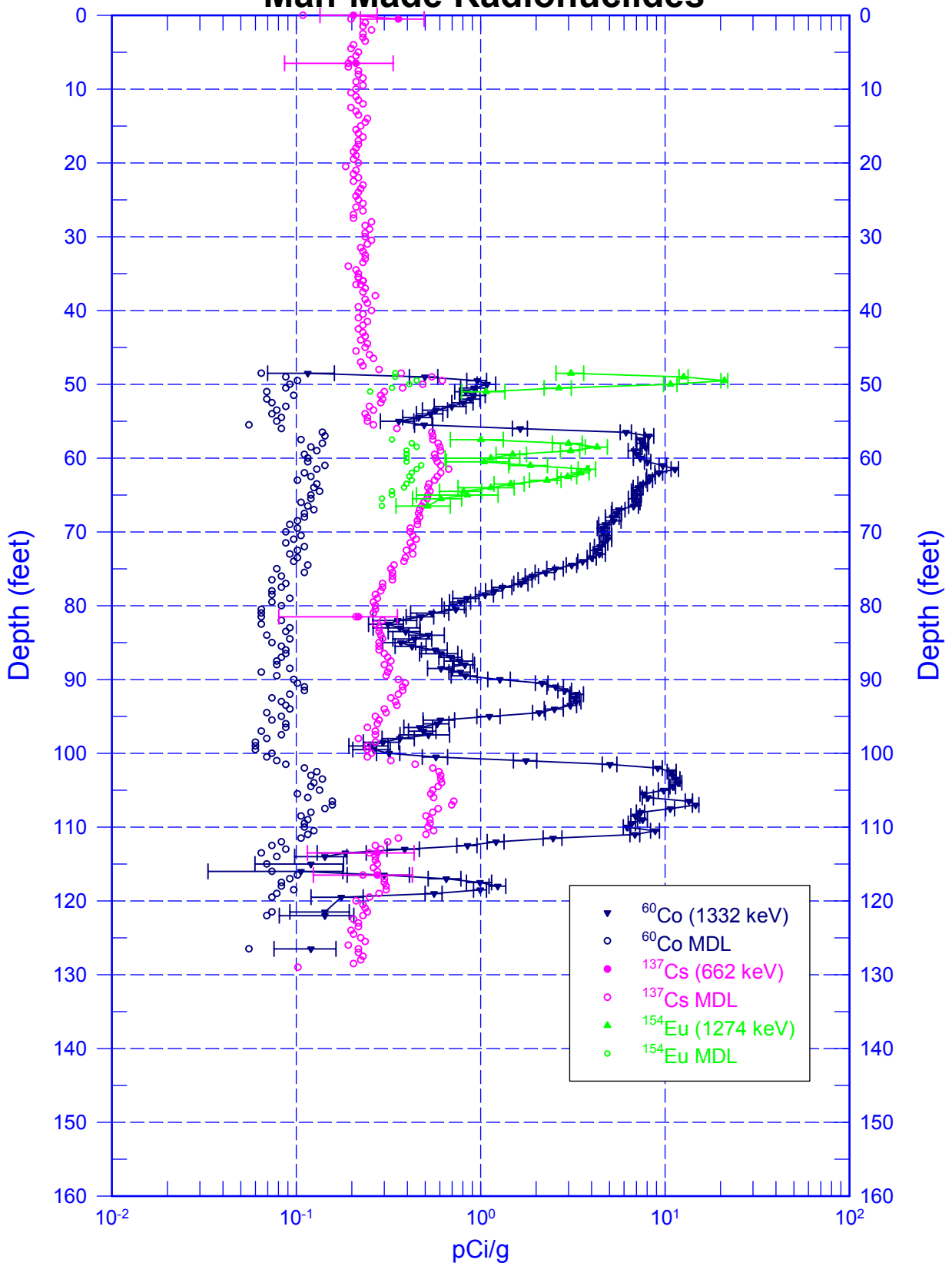
[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not applicable

299-W10-XX (C4105)

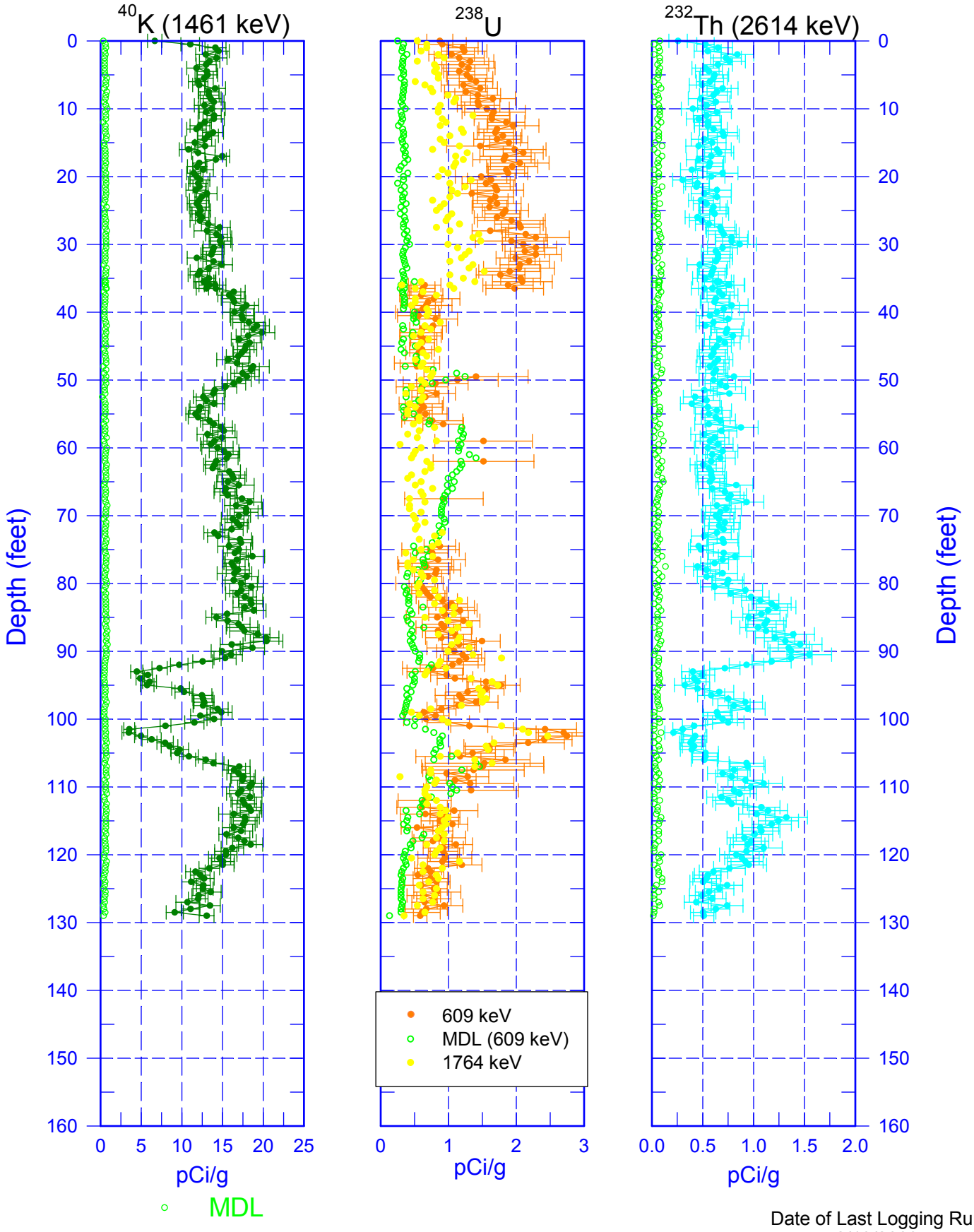
Man-Made Radionuclides



Zero Reference = Ground Surface

Date of Last Logging Run
2/19/2003

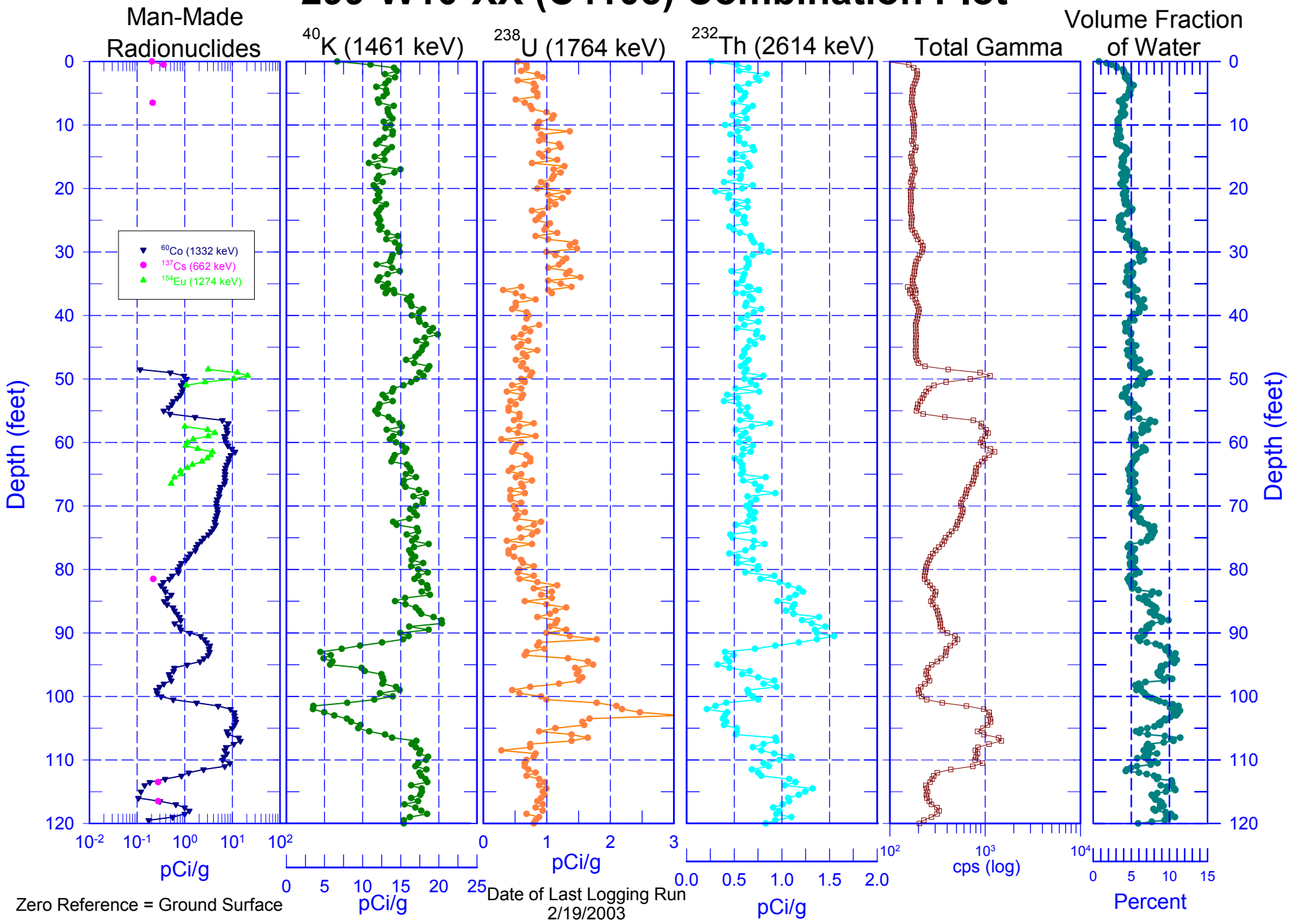
299-W10-XX (C4105)
Natural Gamma Logs



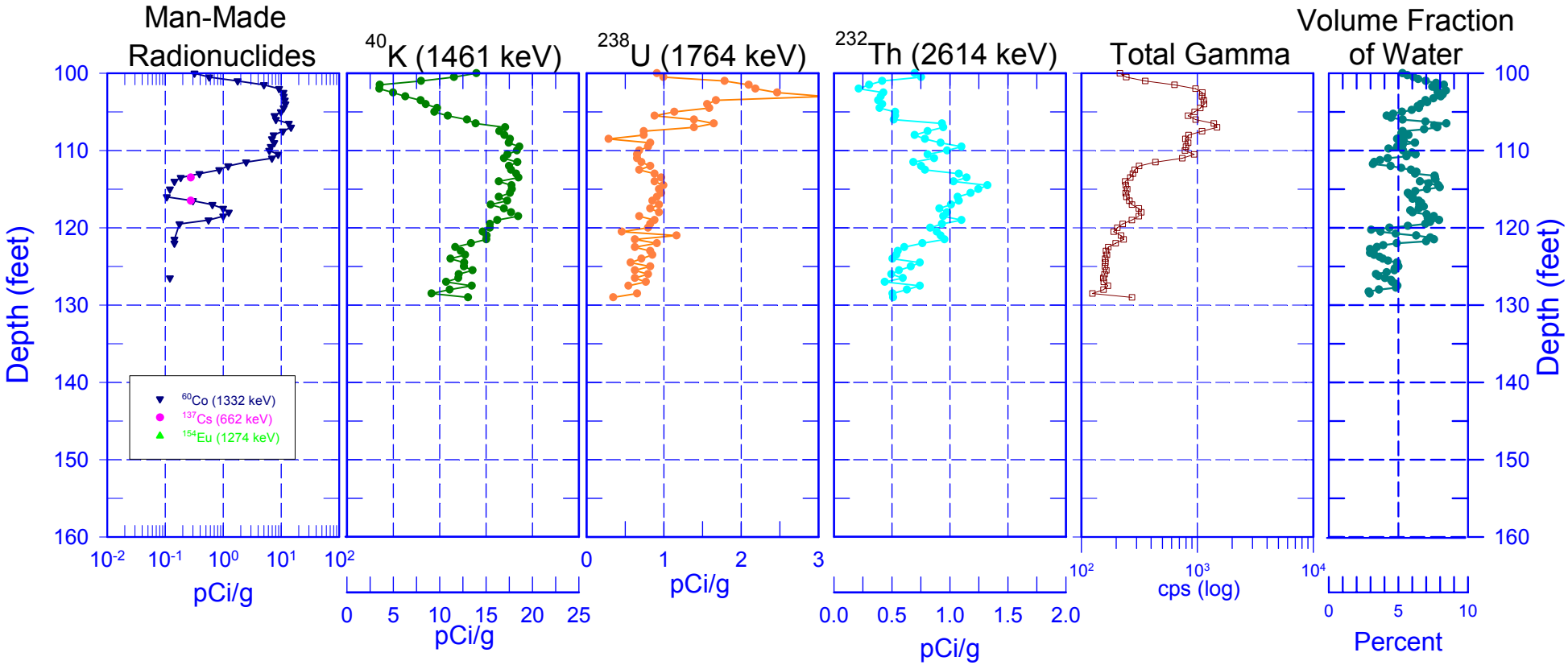
Zero Reference = Ground Surface

Date of Last Logging Run
2/19/2003

299-W10-XX (C4105) Combination Plot



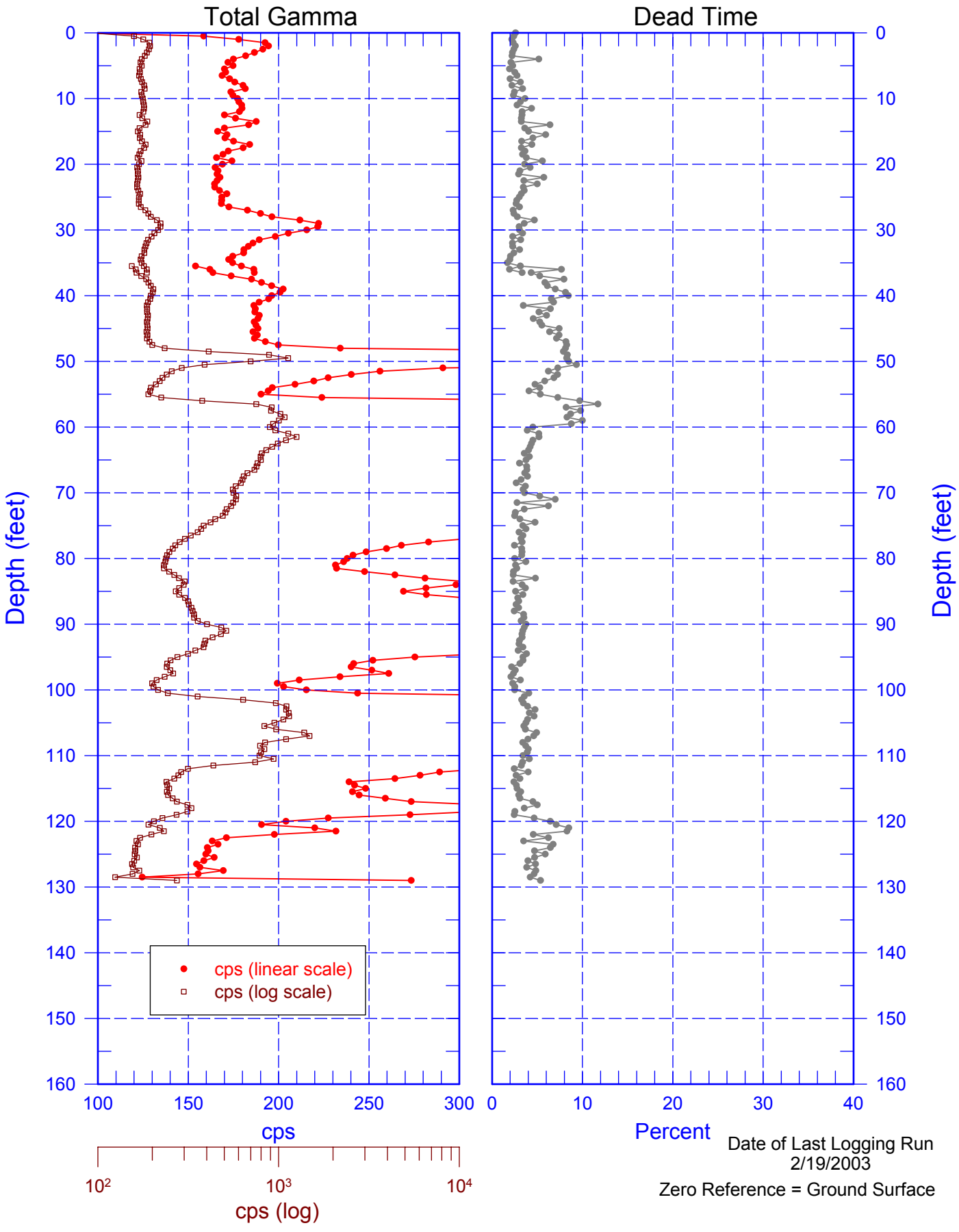
299-W10-XX (C4105) Combination Plot



Zero Reference = Ground Surface

Date of Last Logging Run
2/19/2003

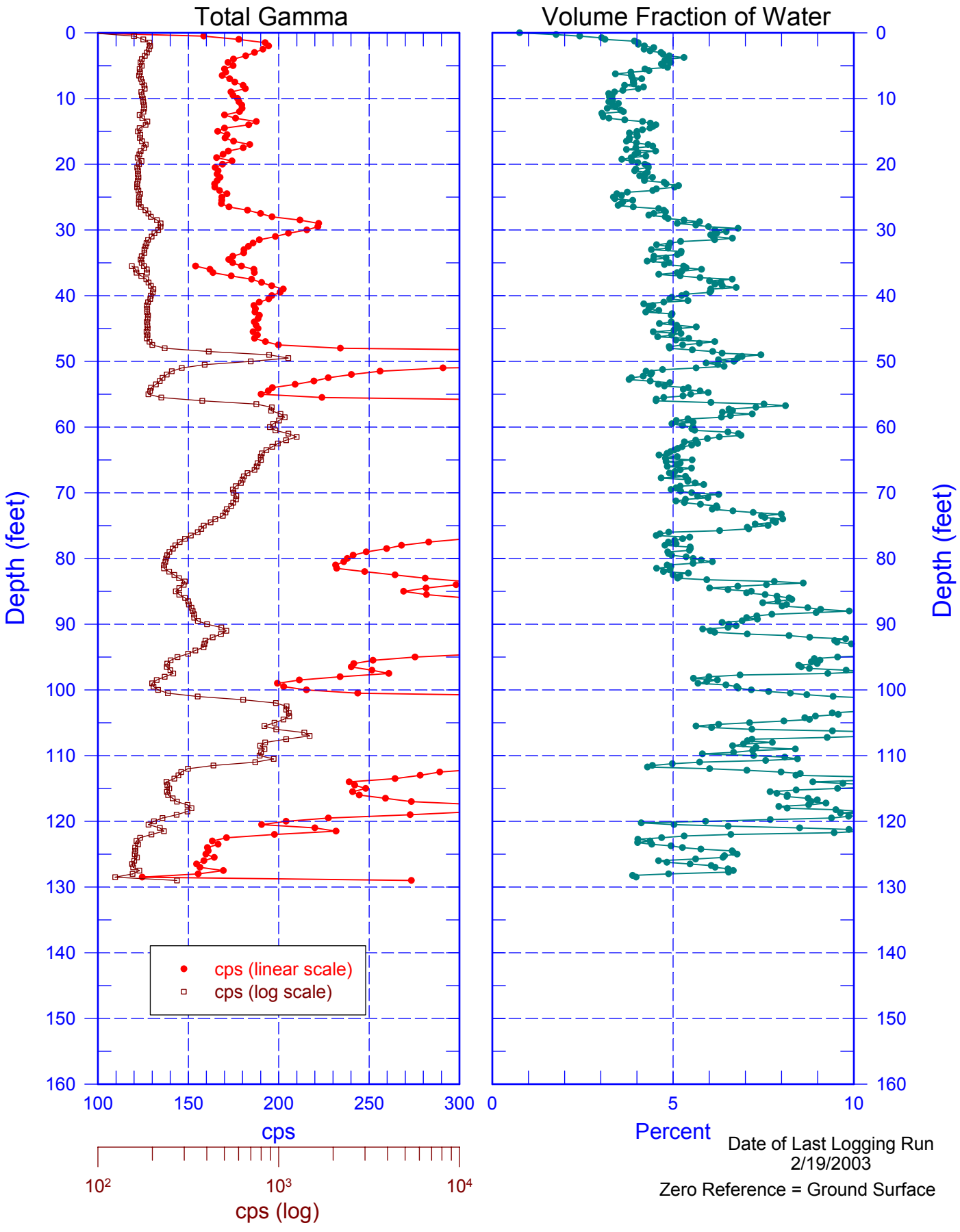
299-W10-XX (C4105)
Total Gamma & Dead Time



Date of Last Logging Run
2/19/2003

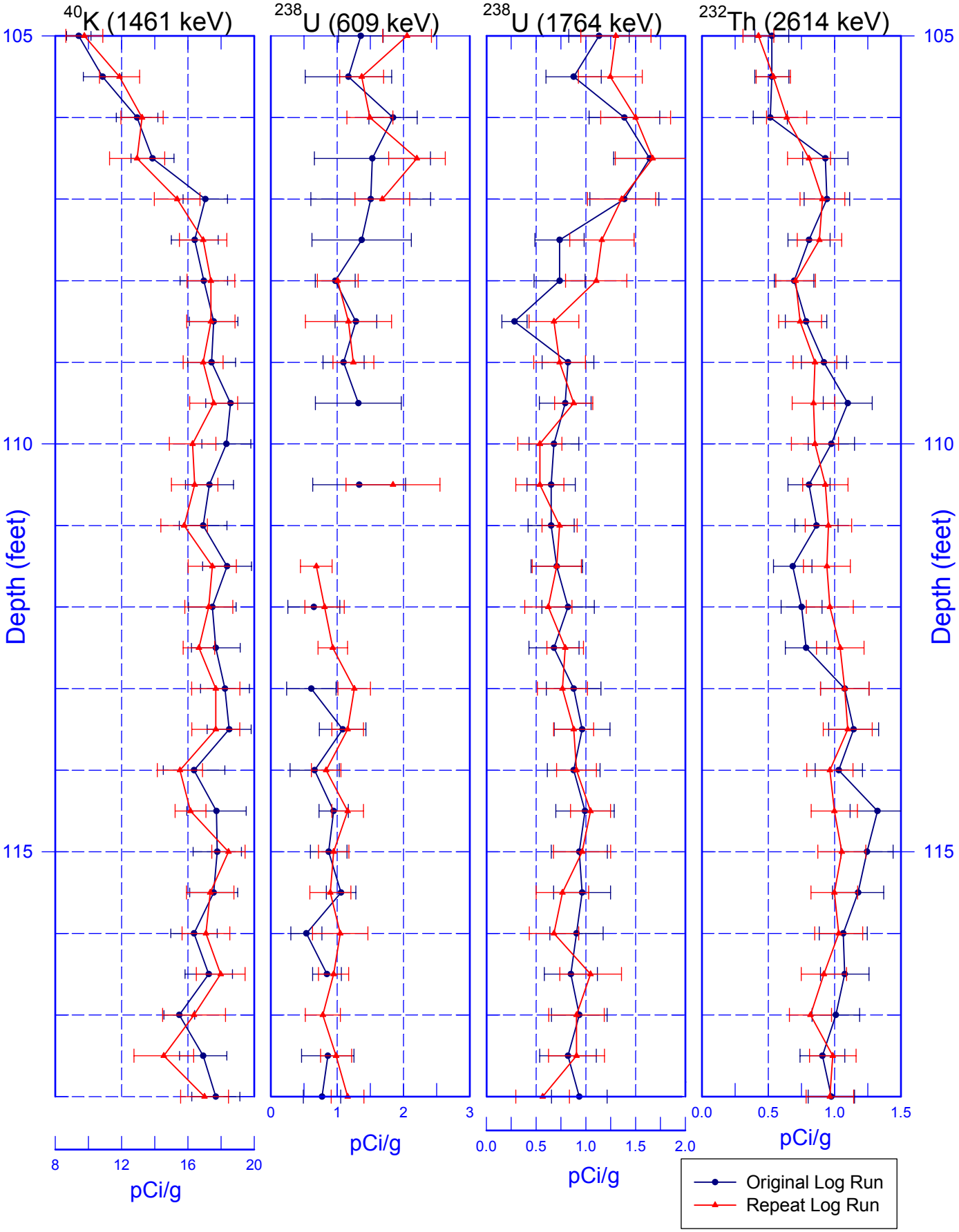
Zero Reference = Ground Surface

299-W10-XX (C4105)
Total Gamma & Neutron

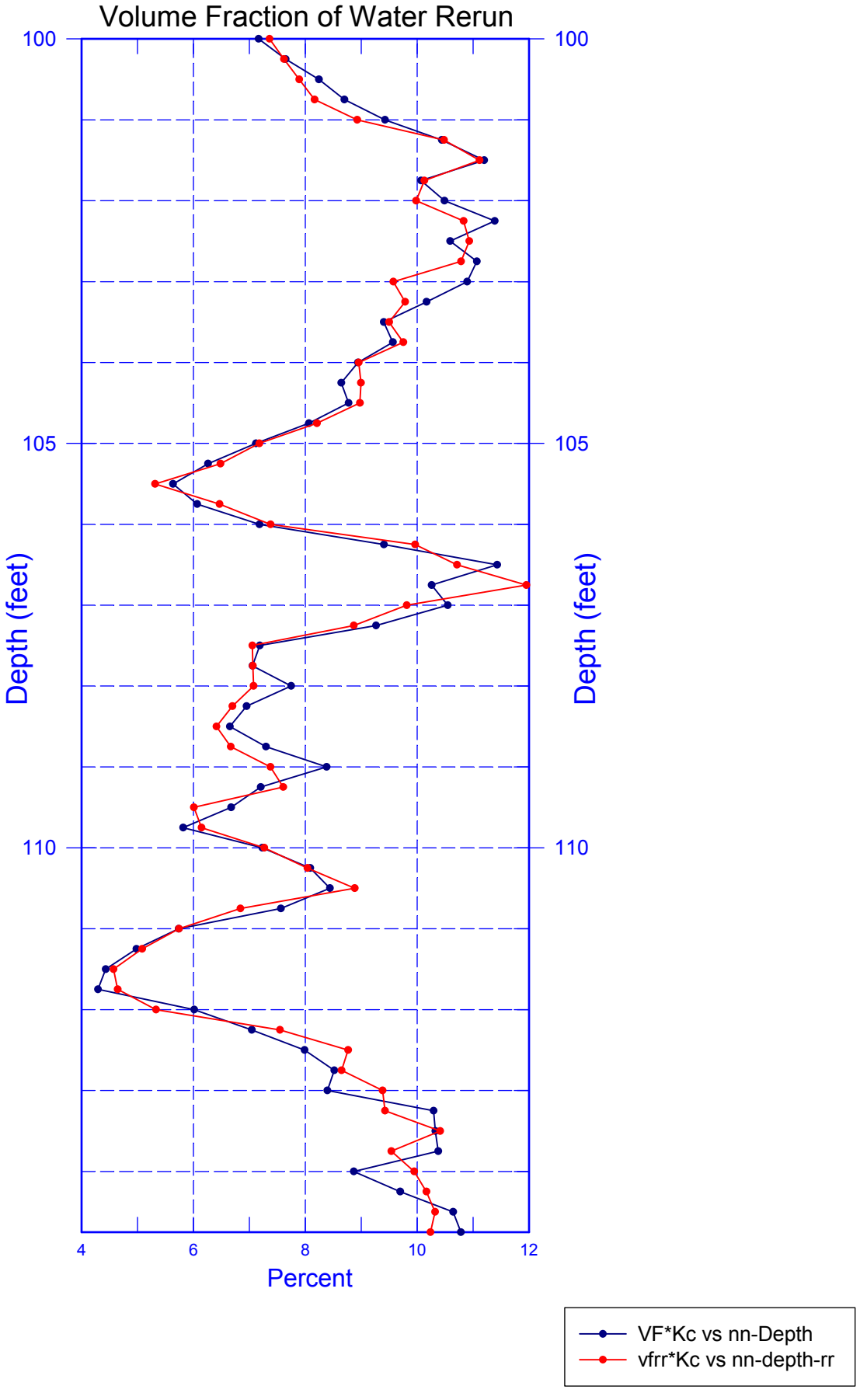


299-W10-XX (C4105)

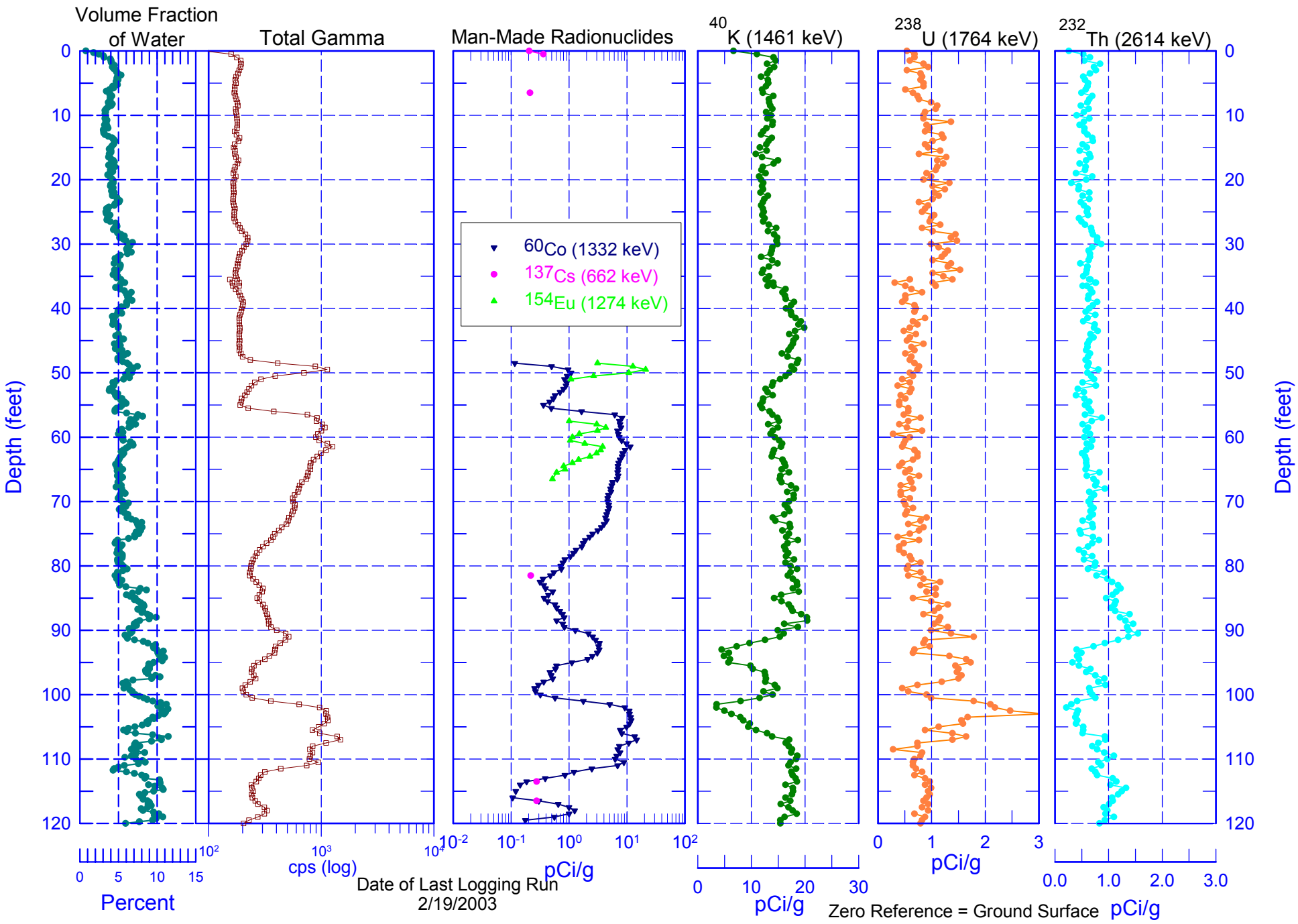
Rerun of Natural Gamma Logs (105.0 to 118.0 ft)



299-W10-XX (C4105)



299-W10-XX (C4105) Spectral Gamma Ray and Moisture Log Survey



299-W10-XX (C4105) Spectral Gamma Ray and Moisture Log Survey